Proposal: Develop a Polarized Dimuon Experiment @Fermilab

- Physics Goals: Physics with single spin asymmetry
  - Transverse SSA in Drell-Yan to test sign change, a test of fundamental QCD prediction:

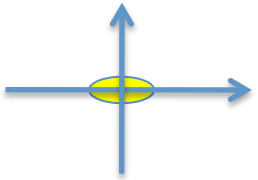
$$f_{Siv}^{DIS}(x,k_T) = -f_{Siv}^{DY}(x,k_T)$$

  - TSSA in J/Psi with polarized target
- Polarized targets, but no polarized beams
  - NH_3, pol = 80%, D= 0.22
  - LiD, Pol = 25%, D = 0.45

$$\delta A_N = \frac{1}{D \cdot P} \cdot \frac{1}{\sqrt{N}}$$

E906 parameters @ Main Injector

- Beam energy = 120GeV
- Beam structure and profile:
  - $2x10^{12}$ protons/sec, for 5 sec/per min
  - Beam size: $\sigma_x < 10mm$ and $\sigma_y < 5mm$,
  - Two years' total = $7x10^{18}$, 15% efficiency



- Magnet: 8.4 T*m
  - pT kick ~ 2.5GeV
- Absorber: 15 λ_I, beam dump 30λ_I
  - Energy loss = 3.5GeV, E906 cut: p > 15GeV
  - Multiple scattering 170/p mr
  - Mass resolution = 240MeV @J/Psi
- Targets: < 15% λ_I
  - 50.8cm liquid hydrogen and deuterium
  - ^{12}C, ^{56}Fe, W

Our Proposal

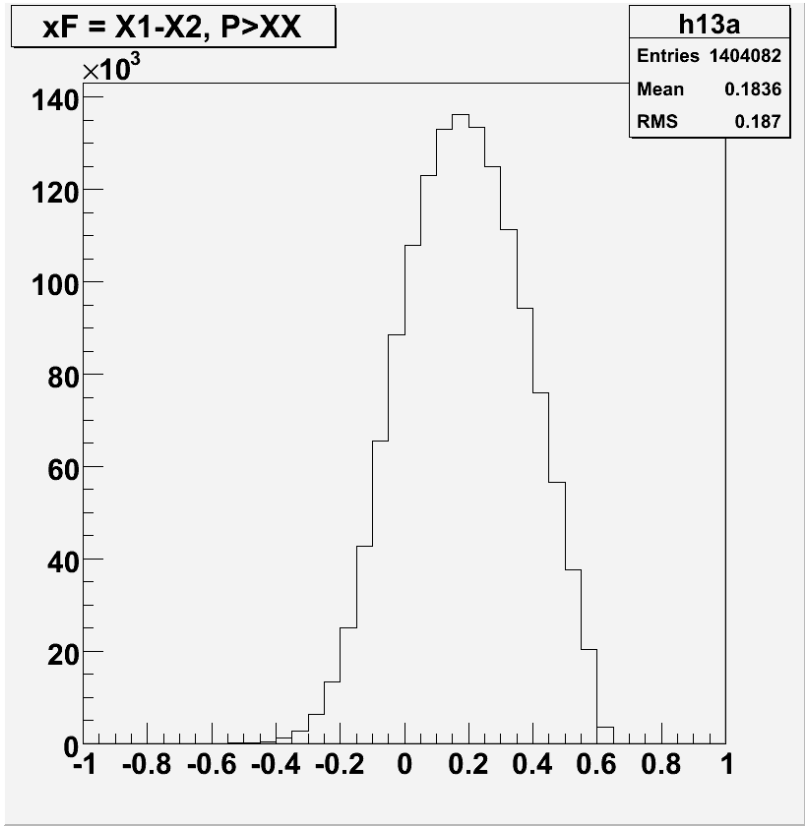
- Polarized target R&D in collaboration with UVA:
  - NH_3:
    - JLab, current Hall C target, for benchmark
    - LANL target.
  - R&D for high intensity proton beams @120GeV
- Detector simulation and reconfiguration
  - Explore wider kinematic, particularly the negative xF region to test the sign change in DY Transverse SSA
- A DOE proposal for a follow up polarized target dimuon experiment after E906.

Pythia Simulations

- Fixed target 120 p+p,
  - 30M events with M>4GeV => 1.3×10^{16} p+p collisions
    - $1.3 \times 10^{16} / 7 \times 10^{17} = 1.8\%$ of two year delivered protons with 100% collisions
    - This is equivalent to 2x9 months E906 run with 50cm hydrogen target
  - Minimum P > 5, 10, 15 GeV
  - Included both mu+mu and e+e channels for statistics
- Target length:
  - JLab 3cm NH_3 for bench mark
  - need ~30cm target?
- Simulation plots
  - http://p25ext.lanl.gov/~ming/E906/pythia_sim/

Benchmark 2x30M to E906 Run

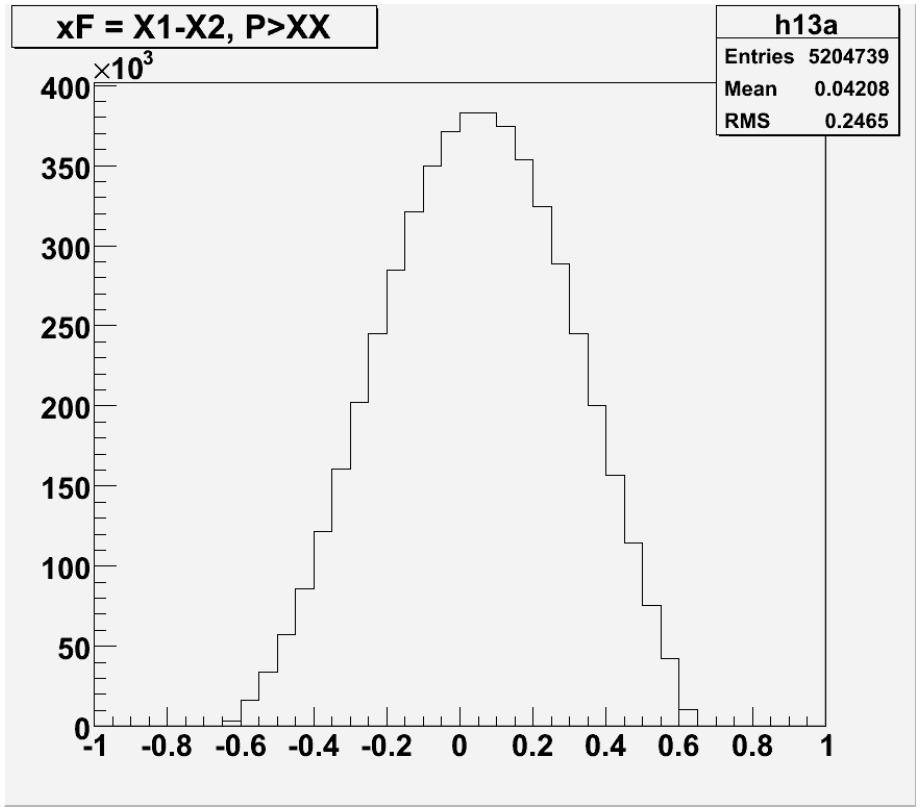
- M>4.2 and Pz > 15GeV
- Total events: 1.4M
  - Equivalent to 4x9 months E906 run (~400K)
  - 50cm liquid hydrogen target (eq. ~4 cm NH_3)



Pol target Experiment

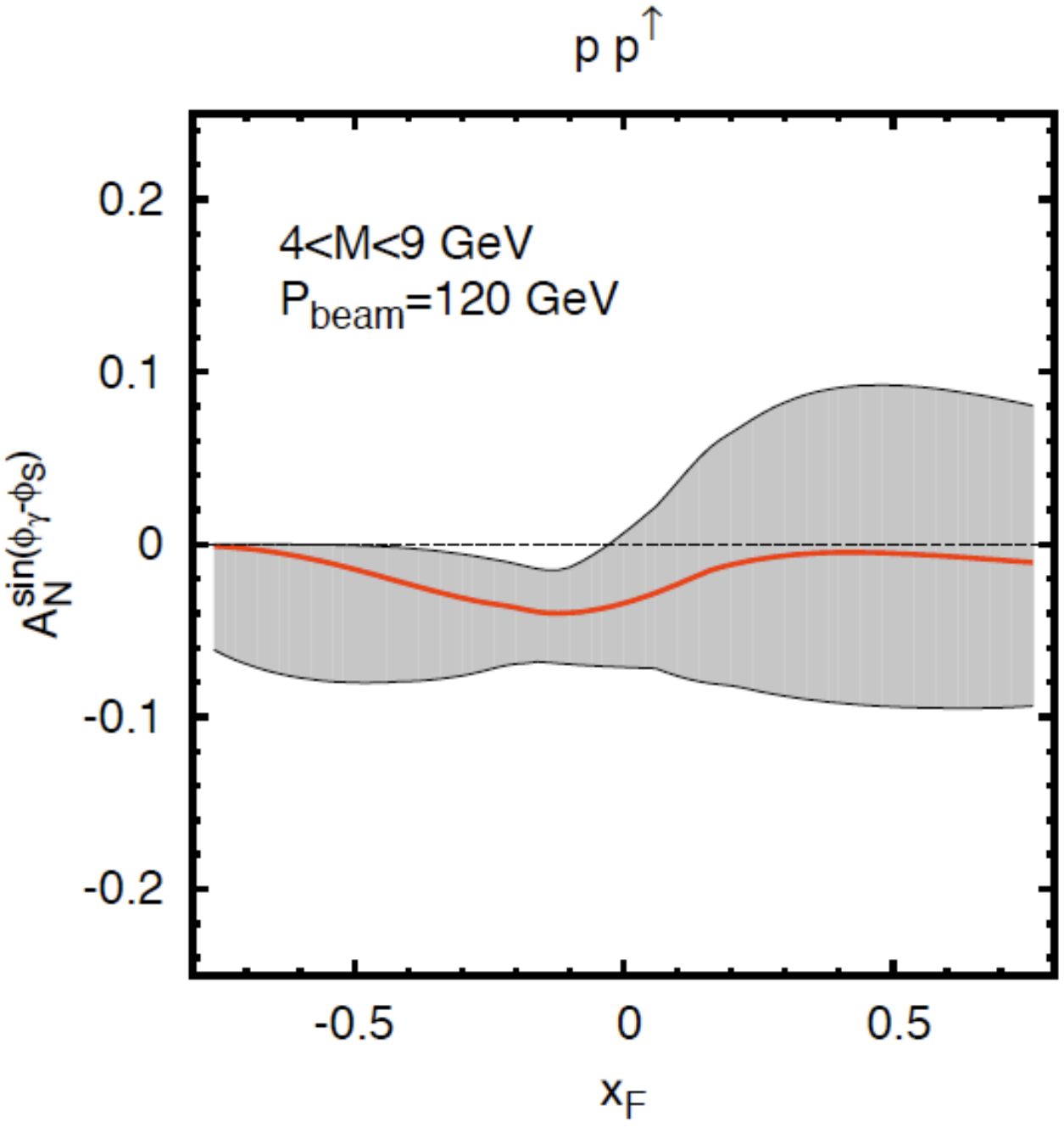
- M>4GeV, P > 5GeV to access negative xF
- 5.2M events
  - 4x9months E906 run
  - 50cm liquid hydrogen eq. target

$$\delta A_N = \frac{1}{D \cdot P} \cdot \frac{1}{\sqrt{N}}$$



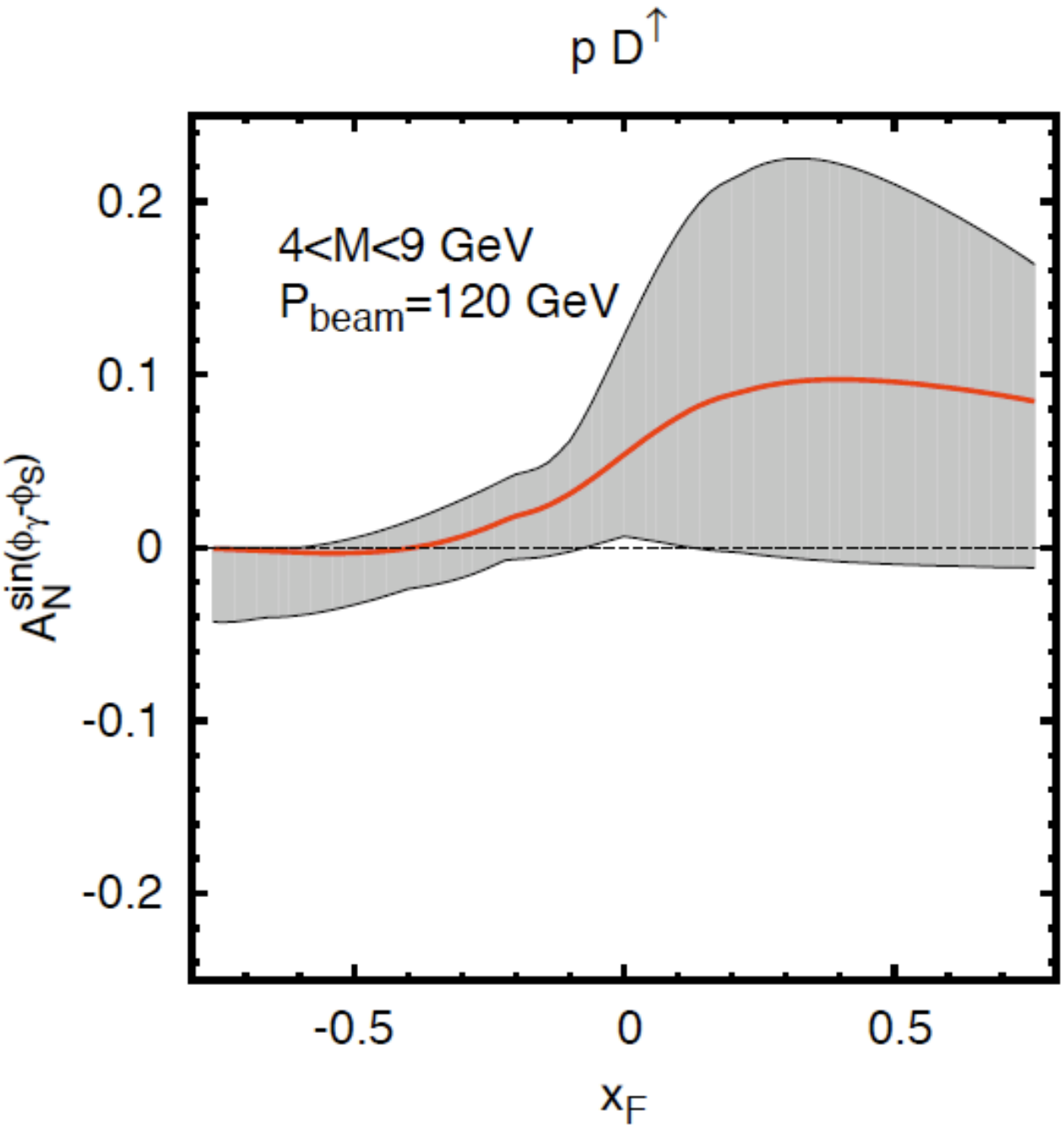
Sensitivity plots

- Anselmino group's calculations:



I. P_z>15 GeV/c
4 x-bins in x_F=0.0-0.4
100k DY events in each bin.
$\delta(A_N)$=±1.8%

II. P_z>5 GeV/c
8 x-bins, in xF=-0.4~0.4.
200k DY events each.
$\delta(A_N)$=±1.3%.


p D↑
4<M<9 GeV
P_beam=120 GeV
A_N^sin(φ_γ-φ_S)
0.2
0.1
0
-0.1
-0.2
-0.5
0
0.5
x_F